

4.5 Calculation of inbreeding and relationship, the tabular method

Calculation of inbreeding and relationship can be done by means of the tabular method. The big advantage of the tabular method is that a graph of the pedigree is not needed. Simultaneously there is only need to concentrate on two generations at one time, as the method always moves from the older to the younger animals. Therefore it is possible to build on the inbreeding and relationship of the preceding generation, as each level only points back to the parents.

Only two simple formulas are applied in which the relationship and inbreeding have the symbols a and F , as shown in the following two points:

1) Inbreeding in an animal (X) is equal to half the relationship between its parents, A and B, and the additive relationship with oneself is

$$a_{XX} = 1 + F_X$$

2) The additive relationship between two animals, X and Y, are equal to half of the relationship between the oldest (X) and the parents, A and B, of the youngest (Y).

$$a_{XY} = (a_{XA} + a_{XB})/2$$

The construction of the relationship matrix are shown in the following points.

- 1) Put the number of all animals in a line (the oldest first)
- 2) Put the number of each individual's parents above the number of the individual.
- 3) Copy step 1) in a vertical column at the left side of the paper
- 4) Write a row of 1's diagonally
- 5) Calculate the relationship between animal 1 and 2, 3, 4 etc. to n
- 6) Copy the first row in the first column
- 7) Calculate the relationship between animal 2 and 3, 4 etc. to n
- 8) Copy the second row in the second column
- 9) etc. - - half of the parents relationship is added to the diagonal element, if relevant step 9 shall be carried out before step 7

Example of application of the tabular method

Using the following set of data.

Animal	Sire	Dam
1	0	0
2	1	0
3	1	0
4	1	0
5	3	2
6	3	4
7	5	6

For hand calculation the steps from 1 to 4 is shown first. (-) means an unknown parent

Parents Animal	- -	1 -	1 -	1 -	3-2	3-4	5-6
	1	2	3	4	5	6	7
1	1						
2		1					
3			1				
4				1			
5					1		
6						1	
7							1

The next steps (5 and 6) is to fill out the first row. The first value is the value for animal number 2. Look at the column of the parents, which shows 1 and - (unknown). The value in column 1 is 1, and unknown is equal to 0, which equals $(1 + 0)/2 = 1/2$ which is put into column 2. The same result is obtained for animal 3 and 4. For animal 5 the parents are 2 and 3, in their corresponding columns is $1/2$ and $1/2$, which added and divided by 2 gives $1/2$. The results are the same for animal 6 and 7. Now row one is copied into column one as seen below.

Parents	- -	1 -	1 -	1 -	3-2	3-4	5-6
Animal	1	2	3	4	5	6	7
1	1	1/2	1/2	1/2	1/2	1/2	1/2
2	1/2	1					
3	1/2		1				
4	1/2			1			
5	1/2				1		
6	1/2					1	
7	1/2						1

Then continue to row two (step 7 and 8). Animal 3 and 4 have 1 and unknown as parents. In column one second row is $1/2$, which equals $(1/2 + 0)/2 = 1/4$ for animal 3 and 4. For animal 5, which have the parents 2 and 3, we have 1 and $1/4$ in the two corresponding columns, this gives $(1 + 1/4)/2 = 5/8$. Animal 3 and 4 are parents of animal 6, their average relationship to 2 is $1/4$, which is put into the diagram. Animal 7 has the parents 5 and 6, their average relationship to 2 is $(5/8 + 1/4)/2 = 7/16$, which is put in. The new results are copied to the corresponding places in column 2.

Parents	- -	1 -	1 -	1 -	3-2	3-4	5-6
Animal	1	2	3	4	5	6	7
1	1	1/2	1/2	1/2	1/2	1/2	1/2
2	1/2	1	1/4	1/4	5/8	1/4	7/16
3	1/2	1/4	1				
4	1/2	1/4		1			
5	1/2	5/8			1		
6	1/2	1/4				1	
7	1/2	7/16					1

Now we can continue filling in the table by repeating steps 7 and 8. Remember (step 9) that half of the relationship between the parents should be added to the diagonal element. This is not relevant until animal 5, where the parents, 2 and 3, have a relationship of $1/4$, which can be read in row 2 column 3. Remember, if relevant step 9 should be carried out before step 7.

Parents	- -	1 -	1 -	1 -	3-2	3-4	5-6
Animal	1	2	3	4	5	6	7
1	1	1/2	1/2	1/2	1/2	1/2	1/2
2	1/2	1	1/4	1/4	5/8	1/4	7/16
3	1/2	1/4	1	1/4	5/8	5/8	5/8
4	1/2	1/4	1/4	1	1/4	5/8	7/16
5	1/2	5/8	5/8	1/4	1 + 1/8		
6	1/2	1/4	5/8	5/8		1	
7	1/2	7/16	5/8	7/16			1

The final table:

Parents	- -	1 -	1 -	1 -	3-2	3-4	5-6
Animal	1	2	3	4	5	6	7
1	1	1/2	1/2	1/2	1/2	1/2	1/2
2	1/2	1	1/4	1/4	5/8	1/4	7/16

The tabular method is simple to computerize, so this method should be used in large animal populations.

The path graph is best used in relation to the genealogy, where good overview is important. In such cases the individual animal can play an important role.